Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE HYGIENE OF THE ATMOSPHERE.

BY SAMUEL LOCKWOOD, PH. D.

THE popular judgment regards the snow and the air as emblems of immaculate purity. But if the former be melted in a vessel, and the water allowed to rest, its sediment will dispel the illusion. The snow in its descent has filtered the air, not only of visible substance, but also of some of its adulterant chemicals.

For a considerable depth, at least, the entire crust of the earth, excepting the crystalline rocks, is permeated with air. It is easy to find out pretty nearly what the weight and volume of this earth-air may be in a given known quantity of soil or mineral, taking a hundred cubic inches of air to weigh thirty-one grains. Suppose a quart vessel to be filled with earth, the weight being first determined. Let water be supplied until it will absorb no more. The air is now expelled, the increased weight is then ascertained, and the rest is simple. Thus we are confronted with the fact of an atmosphere which envelops our persons and which also penetrates the earth beneath our feet. This latter has been called by investigators the ground-air, and in some gravelly and sandy soils its volume is equal to fifty per cent.

The nether atmosphere, or ground-air, may, in spots, be the home of pestilential gases, due to putrescent matter in or on the soil, and known technically as miasmatic or malarial emanations. Such are usually swampy regions, but in every case the evil is superficial, and generally removable by man. Let us prefer to show the beneficent relation which the nether bears to the upper atmosphere, in their respective hygiene.

As the earth beneath is a laboratory for evolving nitrogen and making carbonic-acid gas, it thus becomes very largely the source of a food-supply to the roots of plants. It is also the chief aërial sustenance of all vegetation ; for it is constantly escaping at the surface of the ground. Were it to accumulate there it would be disastrous to living things; so, albeit a much heavier gas, by the law of diffusion, or the kinetic force, it is rapidly disseminated and commingled with the air; yet, though greatly in the minority, every molecule of this gas scorns alliance with any molecule of the atmosphere proper. Thus is secured a dilution of the former, which, to the animal, is harmless, and to the plant beneficial.

With no straining after evidence of design, we may assert for Nature "a solemn league and covenant" in this one example of the conservation of the physical forces. Herein is also a beautiful illustration of the natural economics in hygienic chemistry. It is a quaternate compact. Thus with the correlation of forces as a quasi-constitution or basis of agreement, a mutual contract seems to have been entered into between four parties, securing equal and commensurate benefits. Of these, two of the parties in the alliance are organic, and two are inorganic. The atmosphere contributes of its opulence of oxygen, the vital gas, in conjunction with the essential nitrogen. On the oxygen the respiration of the animal depends; so it evolves carbonic-acid gas, which it contributes to the air for the support of the plant. So, too, the earth crust, with its ground-air, draws on the oxygen, and with its stored carbon also generates carbonic-acid gas, thus also as a solvent preparing plant food. But in this elaboration heat is evolved; so there are begotten thermal conditions of great advantage to the roots of the plant. For their contribution of carbonic-acid gas to the air, both the sentient animal and the insentient earth take oxygen in exchange. By this kinetic commerce the atmosphere maintains its normal balance of one part by volume of carbonic-acid gas to twenty-five hundred parts of air. And what about the fourth member in this righteous, though selfish compact—the plant? It has received generous nutriment from all three. Not to dwell on particulars, it returns to the air the oxygen and nitrogen, and to the earth the carbon. And this compact of conservation goes on in an increasing round of harmony, more practical far than the "music of the spheres."

And in this compact of the natural forces do we not see at least three remarkable facts? No loss of energy; no waste of material; and the minimum of cosmic wear. The common notion is that Mother Earth is throwing off the caloric of her deep fires, much as a prodigal consumes his substance. If I read the evidence correctly, it appears that the laboratory of the earth-rind, in its process of using the ground-air, in converting the oxygen and carbon into carbonic-acid gas, is like a perpetual furnace ever making heat, because its fuel fails not. Hence the earth-rind, in this tireless energy of converting the oxygen of the ground-air, with the carbon stored in the crust, into carbonic dioxide, is a perpetual heat-generator, and unfailing furnace, because its fuel fails not. Hence the cooling of the globe by radiation of its internal heat has herein a considerable offset. So it seems supposable that if the refrigeration of Earth is in the cosmic plan, it is set for some æon in the future. Thus, as a home of life, the perpetuity of the sphere and the quality of its envelope are guaranteed.

The atmosphere is a vast, thirsty sponge ; and though we speak of dry air, it is never without vapor. The earth roots of the giant cactus in the burning plains are little else than grapnel anchors. Into the air it puts out fibrils, aërial roots, and these reach into and suck the vapor-laden air, as a moistened sponge.

The fact which bears on this is the weight of the air, for it is not imponderable. Moreover, its pressure is a variable quantity. In its normal state this pressure is comfortable. The discomfort, and sometimes danger, comes of the thermometric and the barometric changes ; for thus the molecules are brought closer together, and the great air-sponge is the more absorbent, thus more rapidly robbing the body of moisture and heat. From this increase of pressure comes the increase of absorbing power ; hence appears the difficulty of the problem how to ventilate dwellings without subjecting the occupants to a draft. In the winter we must warm our rooms artificially. But this means that we must heat the air we breathe. Now, this air, however pure it is, even if taken directly from the outer air, always contains dust, the consuming of which in heating the air will certainly produce some, however little, carbon monoxide.

Our plan does not require the giving in detail the names of the many substances which the chemist can detect in the air. Their proportion to the mass is so small that they may be compared to the rare gems in the mineral mass of the earth-rind. When the functions of oxygen, nitrogen and carbon are told, this set will embrace the chief essentials of the animal and the plant. But there is still one word about which very unwarrantable notions, if not a good deal of unnecessary mystery, exist. Many years ago Van Marum observed that the passage of the electric spark through oxygen produced a pungent odor, and affected otherwise the known properties of this gas. In a word, it became altered oxyyen—or, technically, it took on an allotropic form. To be quite plain: A molecule of oxygen is a union or impact of two atoms of the element, while a molecule of ozone is a "combination" of three. But as the corroding energy of the triplet is many times that of the twin, the latter has been called relatively passive and the former active oxygen.

In 1840 Schönbein named it ozone, literally the smelling or pungent gas. He found it in the atmosphere, and advanced the idea of its connection with catarrhal diseases; but of this he gave no proof. Ozone is oxygen in its most active condition, having an active eroding and destructive energy—that is, a very greatly increased oxidizing power. It is destructive of germs or organisms in the air; and this energy over thickly-populated places, finding so much material for its exercise, is really turned upon itself, as if suicidal, for it becomes converted back to oxygen. Hence the paradox that, though plentiful in city air, ozone is even there a rare gas. The air of mountains and at the seashore contains ozone in some quantity. In forests, it can hardly be found except high up in the trees, it being restored to oxygen by its expended energy on the leaf or dying vegetation on the ground. In the air over most open fields it is also found, though a French *savant* was not able to find it higher than forty-six feet from the ground.

The air is tenanted with inorganic and organic forms of extreme subtilty, germs both quick and dead.

In the old practice, infectious diseases were too often considered due to a malign influence or principle in the air. Though malignly, the plague was "divinely" sent. But science has her occasional prophet, like a voice in the wilderness, foretelling, he knows not how, some truth which the delving *savant* will afterwards establish by discovery or demonstration. Hence far more interesting to me than he of fiction is the John Ward, preacher by ordination, and administrator of physic without dispensation, the Vicar of Stratford-upon-Avon, from 1662 to 1681. His diary, written in Latin, obtained celebrity because of a bit of gossipy tradition which he tells, that Shakespeare died of a fever contracted in a carouse with two boon poets, Michael Drayton and Ben Jonson. But truly worthy of renown is a passage which contains the grand truth of modern pathology and hygiene, the germ theory. As I have only seen it in the Latin, a translation must be given.

> "There is a plague-producing poison flying through the air, a congeries of excessively minute animalcules, which, entering human bodies, either by the breathing passage, or the pores of the skin, gnaw and destroy these parts. And from these they fly to other bodies, or alight upon them in a similar way; and propagating like a contagion, they infect these others, gnawing and destroying them, as they did those bodies from which they came. . . . This poisonous presence, as above, has made many lie sick, not only of the plague, but also of other diseases"

With medicaments for body and spirit both, this John Ward, vicar, was an active worker in the "great pestilence" of 1665. Hence the allusion in the words "plague" and "plague-producing" is apparent. To-day, instead of "animalcule" we use the term "microbe," so indispensable to the new science, Bacteriology, which deals with the objects now regarded as the germs of disease.

How far the doctrine reaches is not yet determined; but it is indisputable that some contagious diseases are sown by the air. And this is true of the diseases of both animals and plants. Near my home was a grove of red cedars, and seven miles from the grove was an apple orchard. Early in the autumn the cedars were heavily weighted with an unsightly crop of fruit looking like stringy, or ragged oranges. It was a growth of the common cedar apple, a true fungus, known as a *gymnosporangium,* or one of the fungi which have naked spore-vessels. The next season the orchard was badly smitten with disease. Every tree looked as if scorched by fire; every leaf was brown instead of green, and had many eruptions of the epidermis like little boils. Each eruption was a tiny spore-filled cup of the fungus *ræstelia.* Now for a curious fact: for a long while fungologists regarded these two fungi as of genera so widely distinct as not to be cognate. It is now known that they represent stages in the life-career of one and the same species. The spores of the cedar apple, if sown on the leaves of the cedar, will not germinate; whereas, if sown on the apple tree, they will grow, but not into *gymnosperms,* or cedar fungi, but into *ræstelia,* the apple-leaf fungus. And, conversely, the spores of the *ræstelia* will not grow on the apple tree; but carried by the winds to the cedar tree, they will grow there and produce the true cedar apple.

Omnipresent in the atmosphere are the invisible spores of the fungi, known as the *torulacei.* They beget many of the moulds and mildews seen on decaying vegetation. Some of these act also as ferments, decomposing vegetable and animal matter. Of this group, for good and evil, the air almost everywhere contains the spores of the *torula cerevisiæ* or yeast-fungus, literally the mother of vinegar, alcohol and leavened bread.

And in respect of those microbes of the atmosphere which are set down as germs of disease, it can hardly be doubted that their relation to the fungi is pretty close. They are really plants, mostly known under the generic names of *bacilli* and *bacteria.* They are usually rod-like in form, and so small as to be invisible, except with the skilful use of a well-equipped microscope. Each rod perpetuates its species, either by self-division or by spores. Generally these tiny sprites love darkness rather than light. Some seem set for goodness, and some for evil ; for some are scavengers removing by fermentation or putrefaction, and others are propagators of disease. Their vitality is marvellous. They will come out of melting ice full of vigor for mischief, and the spores of some will resist the heat of water nearly to the boiling-point. As with us higher mortals, protoplasm is the life-stuff in these infinitesimals ; and this instable substance will break up under much exposure to the oxidation of the atmospheric air, in sunlight. Yet the anthrax thrives and lives, long multiplying in the buried beast, and coming to the surface to be eaten with grass.

A fact of no common interest respecting these microbes is the diurnal fluctuations of their habitancy of the air. The presence of *bacteria* always rules high at about eight o'clock in the morning. Then begins a gradual decrease until their least presence for the day occurs at the meridian. This lasts for about one hour. Then a gradual increase sets in, and at about eight o'clock of the evening the maximum is again reached. Until about eleven o'clock, or near midnight, their number is considerable, and a great diminution occurs between that hour and three o'clock, when the number begins to rise, until at eight in the morning the maximum is again reached.

But besides these disease-originating organisms, the microbes, the atmosphere carries many other kinds of substance, which perform the rôle of irritants. Though the agents of great suffering, their action does not ordinarily imperil life. Let us consider this feature of the air-dust.

A distressing malady is *æstivis,* or hay-fever. Behind the disease is a neurosis, or supersensitiveness of the nerve centres. The air passages have their mucous walls in a disordered condition, and in a state of tenderness not unlike that of the outer flesh when scalded or denuded of the skin. Hence, generally, air-dust of any kind is a painful irritant to the mucous surface. And probably this is especially true of the organic or vegetable matter in the air. As president of the United States Hay-Fever Association, it seemed my duty to try to throw some light on the question of the difference of the air in places where *æstivis* prevailed, and the regions sought as sanitaria being largely exempt from the malady. Possibly in these mountain retreats, owing to the resins of the balsam forests, peroxide of nitrogen, mistaken for ozone, is present. The air, too, is dryer and its average much cooler, all of which makes the summer climate more tonic. Yet it seemed to me that the chief factor was to be sought in the character of the air-dust itself. In a word, the instrumental work was less with the barometer and the thermometer than with the microscope.

Accordingly in August and September, at my retreat in the White Mountains, at an elevation of about 1,500 feet, I set traps to catch the contents of the air, instructing my son, by correspondence, to do the same at the same time at my home in New Jersey, at an elevation of nearly 300 feet above the sea. His daily catch was put away in an air-tight box to be studied on my return. My mountain catch was inspected with the microscope on each succeeding night. The New Jersey catch was, in time, carefully studied, and compared with that from the mountains, and many careful drawings were made. These traps were simply strips of glass three inches long and one wide, each before exposure, being smeared with pure glycerine.

The mountain traps were well charged with dust. But the inorganic, or road dust predominated. There were also motes of woody fibres, and it was interesting to notice, so nicely were the cells separated, that the kind of wood, namely, the conifera, was at once apparent. The exuviæ of vegetation, in delicate flakes, almost like epithelial scales, were there. And even an occasional trait of some insect structure appeared. All, however, was absolutely invisible to the unaided eye. But the game sought, namely pollen, was truly rare. Doubtless the season was exceptional, such was the frequency of rain. My particular quest was pollen, and only on two traps in fifty did I find any. One yielded five grains of *aster* pollen, and another three grains of *spiræa*. This paucity of pollen was a genuine surprise.

The study of the home slides afforded an astonishing contrast. A single trap gave me over 200 pollen grains of ragweed, or Roman wormwood, probably the very worst irritant of *æstivis*. Then there was hardly a slide without pollen of some kind. Time will not allow for technical descriptions, but there were pollens also of other plants, though the ragweed dominated largely over all. There was mineral dust, too, in great quantity, woody matter, and considerable débris of an artificial sort, such as fibres of woollen and cotton goods, peculiar to populous places. Scales of insects, great quantities of very fine vegetable exuviæ that I have likened to epithelial scales, were present in profusion. But, to my surprise, the traps showed a considerable amount of fungus spores, rather pretty, but decidedly unlovable objects when once inside the air-passages. They were the spores of smut and bent and mould. Some were in the form of tiny barrels, others like pods, and others in granules. But the list is too long to enumerate. As worthy of having their forms preserved for the engraver, nearly two hundred figures were drawn, simply the selection from the catch of seven traps in about one hundred. I did not detect one microbe, though my observations were subjected to some disadvantages which could admit of their escaping detection.

In my judgment, of the ingredients which make up the air-dust, pollen, especially that of the ragweed, is the worst for the sufferer from hay-fever. A statement of the way in which this one ingredient of the air-dust produces torment shall close this inadequate sketch of the hygiene of the atmosphere.

It is easy to understand that for the subject of asthma, or any allied catarrhal affection, to inhale dust is to beget a painful sense of suffocation, and where hay-fever is accompanied with asthma, alarming spasms are thus excited. But this is especially so if in that dust the pollen of flowers is present; for, particularly if the grains be burred or spiny, the effect is to lacerate or scour the supersensitive mucous area. Then, too, in this state of hyperæsthesia, the walls of the air-passages give out an excessive secretion of a hot acrid fluid. This will make a quasi-decoction of the pungent, perhaps poisonous, essential principle of the pollen grain, as in the ragweed.

But the pollen of a flower is set for the performance of a function, exacting of it an individual and peculiar activity, which is displayed in a bit of automatism looking wonderfully like instinct. The style of a flower is composed in part of a loose, or more or less spongy, tissue, while the stigma at the top is charged with a saccharine, sticky mucilage. A pollen grain, borne by the wind or by an insect, usually falls on the stigma, and is anchored to it by the spines sticking into the gum. The moisture causes the grain to swell. There is a protrusion of the membrane at one or more of the thin places at the surface, whence a tube, or root-like process, emerges and penetrates the stigma. It seems to be an extension in a tubular form of the membrane, and is filled with the protoplasm of the cell. Having pierced the outer coat of the stigma, this tubule, by a sort of growth, keeps on lengthening and pushing its way down through the loose tissue of the style until it has reached the ovule at the base when fertilization takes place, and the future seed of that flower is assured.

This is the mysterious activity of the life-force in a pollen grain. And, curiously, this tiny vital automaton can be deceived; hence occurs the exercise of a pseudo-instinct. If one of these pollen grains be put on a drop of sweetened water, it will at once protrude its tubule. What then should hinder this spiny little thing, when its grapnels have taken hold of the mucus-covered membrane of the respiratory passage, from protruding its tubule and actually piercing the warm sensitive wall?

Let us now tabulate these four possible modes of action for the pollen of the air dust in hay-fever.

1. Its suffocating effect simply as an impurity of the atmosphere, thus exciting asthma.
2. As a mechanical irritant, begetting inflammation, even to excoriation of the mucous membrane.
3. As a toxic agent, poisoning the tissues.
4. As a pseudo-parasite, penetrating the soft and sensitive parts.

It should be repeated that these activities are here supposed to operate upon the system while in an abnormal state. In a word, behind all there is a hay-fever neurósis. The nasal ducts are the first to show suffering, the malady extending thence to all the respiratory organs and from these to other parts.

How often has the influenza, "la grippe," in the recent epidemic been the fatal prelude to pneumonia! Now Friedlander's pneumonia coccus, or germ, is known. But have we captured the microbe of this influenza, or catarrhal fever ? True there are noteworthy intimations, but we must wait for the demonstration. Professor Weichselbaum, and the physicians, Adolph Jolles and Maximilian, of Vienna, announce the discovery of the influenza microbe. They say it is "cassock shaped, and of a dark blue color," with some resemblance to Friedlander's. What now, if this Vienna find should prove to be the progenitor of the pneumonia microbe, and in some way not unrelated to the change of fungus which we have instanced.

But why should our surmise stop here ? The meteorological conditions have been unusual for a year or more ; the temperature low in summer and high in winter, with excessive moisture —and late in the fall diseases of our domestic animals, the bovine fever, for instance, and this so closely preceding the catarrhal fever, or influenza epidemic. Hippocrates said, he was told by those who were best acquainted with horses, that they were subject to every ill that afflicts man. What, if in this case, and in this catarrhal fever, or "la grippe," it should prove, as in the fungus cited, that there is an important relation in this respect between man and beast—a lineage of the microbes not unlike that of the fungus propagating by alternations of its host ?

And what an efficient cosmic carrier is our atmosphere. Literally on "the wings of the wind" in a score of days or less the compass of the earth may be made. We all remember the terrific eruption of Krakatoa. Even after the filtration of many months the atmosphere was still adulterated with the impalpable material mist of the so-called vocanic dust—so that, the whole world over, every horizon at sunset was colored with a lurid glow.

The knowledge of the air we breathe, its physical character, the air-dust, its invisible inhabitants, the microbes, their potencies for good or ill—all such should beget a practical wisdom in the sufferer, even though he may be a non-professional ; for intelligently obedient to the laws which he understands, and limiting physic to the concoction of simples, he may for himself and others, like the good vicar, be a wise dispenser, though without a dispensation.

SAMUEL LOCKWOOD.